

FORM PTO-1380

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INTERNATIONAL FILING DATE:
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07 APRIL 1998 (07.04.98)

TITLE OF INVENTION: METHOD AND APPARATUS FOR MAKING PLASTIC FILM, AND PLASTIC FILM

APPLICANT(S) FOR DO/EO/US: Kari KIRJAVAINEN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
 2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
 3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
 4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
 5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau. (see attached copy of PCT/IB/308)
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
 6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
 7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
 8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
 9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
 10. ☐ A translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).
- Item 11. to 16. below concern document(s) or information included:
11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
 12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
 13. ☒ A **FIRST** preliminary amendment.
 - ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
 14. ☐ A substitute specification.
 15. ☐ A change of power of attorney and/or address letter.
 16. ☒ Other items or information: International Preliminary Examination Report (PCT/IPEA/409)
PCT/IB/308
Data Entry Sheet
International Search Report (PCT/ISA/210)

U.S. APPLICATION NO. (if known) 37 CFR 1.61

097647739

INTERNATIONAL APPLICATION NO.
PCT/FI99/00277ATTORNEY'S DOCKET NO.
2980116US//HU/HER

CALCULATIONS PTO USE ONLY

17. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):**

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$ 1,000.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$ 860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$ 710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$ 690.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$ 100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

\$ 1000.00

Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS

NUMBER FILED

NUMBER EXTRA

RATE

\$

Total claims 17 - 20 = 0 X \$18.00 \$

Independent claims 3 - 3 = 0 X \$80.00 \$

MULTIPLE DEPENDENT CLAIMS(S) (if applicable) + \$270.00 \$

TOTAL OF ABOVE CALCULATIONS =

\$ 1000.00

Reduction of 1/2 for filing by small entity, if applicable. Applicant claims Small Entity Status under 37 CFR 1.27. +

\$

500.00

SUBTOTAL =

\$

500.00

Processing fee of \$130 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.49(f)).

\$

TOTAL NATIONAL FEE =

\$

500.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$

40.00

TOTAL FEES ENCLOSED =

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540.00

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a. ☒ A check in the amount of \$ 540 to cover the above fees is enclosed.b. ☐ Please charge my Deposit Account No. **25-0120** in the amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required by 37 CFR 1.16 and 1.17, or credit any overpayment to Deposit Account No. **25-0120**. A duplicate copy of this sheet is enclosed.

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Customer No. 000466YOUNG & THOMPSON
745 South 23rd Street
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Arlington, VA 22202
(703) 521-2297 facsimile (703) 685-0573

October 4, 2000

By

*Benoit Castel*Benoit Castel
Attorney for Applicant
Registration No. 35,041

PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Kari KIRJAVAINEN

Box Non-fee Amendment

Serial No. (unknown)

GROUP

Filed herewith

Examiner

METHOD AND APPARATUS FOR MAKING
PLASTIC FILM, AND PLASTIC FILM

PRELIMINARY AMENDMENT

Commissioner for Patents

Washington, D.C. 20231

Sir:

Prior to the first Official Action and calculation of the filing fee, please amend the above-identified application as follows:

IN THE CLAIMS:

Claim 4, line 1, change "any one of the preceding claims" to --claim 1--.

Claim 5, line 1, change "any one of the preceding claims" to --claim 1--.

Claim 9, line 1, change "any one of claims 6 to 8" to --claim 6--.

Claim 10, line 1, change "any one of claims 6 to 9" to --claim 6--.

Claim 11, line 1, change "any one of claims 6 to 9" to --claim 6--.

Kari KIRJAVAINEN

Claim 16, line 1, cancel "or 15".

Claim 17, line 1, cancel "or 15".

Respectfully submitted,

YOUNG & THOMPSON

By

Benoît Castel

Benoît Castel
Attorney for Applicant
Customer No. 000466
Registration No. 35,041
745 South 23rd Street
Arlington, VA 22202
703/521-2297

October 4, 2000

METHOD AND APPARATUS FOR MAKING PLASTIC FILM, AND PLASTIC FILM

The invention relates to a method for making a plastic film, the method comprising extruding a plastic film and orientating it.

5 The invention also relates to an apparatus for making a plastic film, the apparatus comprising an extruder and at least one orientation device for orientating the extruded film.

The invention further relates to a plastic film which comprises bubbles with the maximum diameter of about 100 micrometers and the
10 maximum height of about 10 micrometers.

Making a plastic film by extruding it and then orientating it is known e.g. from US patents 3,244,781 and 3,891,374. It is, however, difficult to make thin and in particular thin foamed films using these solutions.

EP publication 0,182,764 discloses a thin polypropylene film which
15 contains wide and flat disk-like bubbles, which are about 80 micrometers in length and about 50 micrometers in width. The film is produced by extruding material which has been foamed chemically or by means of gas and by orientating the extruded material biaxially. The result is a very versatile plastic film. However, the foaming degree of the film is less than 50%, which is why
20 the properties of the film are not good enough for all purposes.

Furthermore, it is not possible to produce thin films of polymethylpentene or cyclic olefin copolymer using the prior art solutions.

The object of this invention is to provide a very good and thin foamed plastic film and a simple and reliable method and apparatus for
25 making said plastic film.

The method of the invention is characterized in that before extrusion material is mixed into the plastic of the plastic film, cavitation bubbles are formed in the plastic film to be stretched due to the influence of the material, after extrusion the plastic film is orientated by stretching, and
30 simultaneously with orientation pressurized gas is arranged to act on the plastic film so that the gas diffuses in the cavitation bubbles, and thus bubbles containing gas are formed in the plastic film.

The apparatus of the invention is characterized in that the apparatus comprises gas supply means arranged in one orientation device for
35 feeding pressurized gas into the plastic film simultaneously with orientation by stretching so that the fed gas diffuses in the cavitation bubbles that are formed

in the plastic film during stretching, and thus bubbles containing gas are formed in the plastic film.

The plastic film of the invention is characterized in that material is mixed into the plastic of the plastic film, cavitation bubbles are formed in the plastic film to be stretched due to the influence of the material, and the plastic film is subjected to stretching and to pressure of pressurized gas simultaneously with stretching so that the bubbles contain said gas, the foaming degree of the plastic film being over 70%.

The basic idea of the invention is that a film is extruded from plastic material by means of an extruder and material has been mixed into the plastic so that when the plastic is stretched, cavitation bubbles are formed in the material particles mixed into the plastic. The film is orientated by stretching and at the same time gas is fed into the film under high pressure so that the gas diffuses in the cavitation bubbles and causes overpressure in them. The idea of a preferred embodiment is that after the first orientation the plastic film is orientated by stretching it in the direction substantially perpendicular to the first orientation direction, and thus the overpressure is released in the cavitation bubbles and the bubbles expand.

An advantage of the invention is that very thin films with a foaming degree of about 70 to 90% can be provided in a relatively simple manner. An advantage of the high foaming degree is that the electric and mechanical properties of the film are very good. A further advantage is that the method and apparatus can be used for making a film for example of polymethylpentene or cyclic olefin copolymer.

The invention will be described in greater detail in the following drawings, in which

Figure 1 is a schematic cross-sectional side view of an apparatus of the invention,

Figure 2 is a partially cross-sectional top view of the apparatus illustrated in Figure 1,

Figure 3 is a cross-sectional view of a detail of the apparatus illustrated in Figure 1 along line A-A,

Figure 4 is a cross-sectional view of a detail of the apparatus illustrated in Figure 1 along line B-B,

Figure 5 is a cross-sectional view of a detail of the apparatus illustrated in Figure 1 along line C-C,

Figure 6 is a schematic cross-sectional top view of an extruder used in the apparatus of the invention,

Figure 7a is a cross-sectional side view of a plastic film extruded by the apparatus of the invention before orientation of the film,

5 Figure 7b is a cross-sectional side view of the plastic film extruded by the apparatus of the invention after longitudinal orientation,

Figure 7c is a schematic top view of the plastic film illustrated in Figure 7b, and

10 Figure 7d is a schematic top view of the plastic film made by the apparatus of the invention after longitudinal and cross-direction orientations.

Figure 1 is a side view of an apparatus according to the invention. The apparatus comprises an extruder 1. The extruder may be for example conical, i.e. it comprises a cone-shaped rotor 2, outside of which there is an outer stator 3 whose surface at least on the rotor 2 side is cone-shaped, and
15 inside the rotor there is an inner stator 4 whose surface at least on the rotor 2 side is cone-shaped. When the rotor 2 rotates, it extrudes material which is between the rotor 2 and the stators 3 and 4 from the extruder 1 in a manner known per se. For the sake of clarity the figures do not illustrate e.g. the rotating means of the rotor or the feeding devices for feeding the material to be
20 extruded into the extruder 1. The extruder 1 may comprise more than one rotor 2 and more than two stators 3 and 4. In that case the extruder 1 can be used for extruding multilayer products. The solution with one rotor 2 and two stators 3 and 4 can be used for making two-layer products. The end portion of the inner stator 4 is wide and tapers in the vertical direction so that together
25 with the nozzle 6 it forms a relatively flat and wide gap through which the plastic 5a is extruded. After the nozzle 6 there is a calibration piece 7 whose nuts are used for adjusting the height of the gap, which allows to define the thickness of the plastic film 5 to be obtained from the extruder 1.

After the extruder 1 the plastic film 5 is cooled by a cooling device
30 8. The cooling device 8 may comprise e.g. a cooling roll 9, which is arranged in a cooling tank 10 containing a cooling medium, e.g. water. The plastic film 5 is arranged to be pressed against the cooling roll 9. The apparatus according to Figure 1 uses auxiliary rolls 11 for guiding the plastic film 5 at several points.

After cooling the plastic film 5 is guided to a machine direction
35 orientation device 12. The machine direction orientation device 12 comprises orientation rolls 13 whose velocities are adjusted so that they can be used for

stretching the plastic film 5 and thus for orientation in the machine direction. If desired, the velocity of each orientation roll 13 can be adjusted separately. The machine direction orientation device 12 may also comprise heating means 14, such as radiation heaters, for heating the plastic film 5 in a manner known per se. The orientation rolls 13 can also be used for heating the plastic film by supplying a heating medium, such as heated oil, to the orientation rolls 13 so that the orientation rolls 13 become warm. If desired, the temperature of each orientation roll 13 can be adjusted separately.

The orientation rolls are arranged in a discharge chamber 15. Pressurized gas, preferably air, is fed into the discharge chamber 15 along a gas supply pipe 16. Instead of air, nitrogen or another gas or gas mixture, for instance, may be used as the gas to be fed. The gas to be fed may also be selected according to the desired electric properties. For example, in respect of the dielectric strength of the product it would be advisable to use sulphurhexafluoride SF_6 and in respect of chargeability e.g. argon. The pressure of the gas to be fed is relatively small compared to the typical foaming methods, being preferably about 10 bars, but it may vary between 3 and 20 bars, for instance. Suitable material, such as calcium carbonate particles, is mixed into the plastic 5a of the plastic film 5, and due to the influence of the particles the joint surfaces of the plastic molecules and the mixed material are torn during orientation, and thus cavitation bubbles are formed. When orientation is performed by arranging pressurized gas to act on the plastic film 5, the gas in question diffuses in the cavitation bubbles and causes overpressure in the bubbles. In the discharge chamber 15 the pressurized gas can act on both sides of the plastic film 5, and thus gas bubbles are formed evenly in the plastic film 5. The discharge chamber 15 is sealed at the entry and exit of the plastic film 5 in a manner known per se.

After the machine direction orientation device 12 the plastic film 5 is supplied to a cross-direction orientation device 17. In the cross-direction orientation device 17 the plastic film 5 is stretched in the cross-direction, i.e. orientation is performed in the direction substantially perpendicular to the direction of the orientation performed in the machine direction device 12. Due to the overpressure of the gas in the bubbles and cross-direction stretching the bubbles can grow sideways and also to some extent in the vertical direction in the cross-direction orientation device 17. In that case the foaming degree of the film is for example about 70 to 90%. The foaming degree can be adjusted

simply by adjusting the pressure of the gas to be fed into the discharge chamber 15. The cross-direction orientation device 17 comprises two orientation wheels 18, and an orientation band 19 is arranged against both of the wheels. The orientation band 19 is an endless band which is guided by means of band guide rolls 20. The orientation band 19 presses the edges of the plastic film 5 firmly and evenly between the orientation wheel 18 and the orientation band 19 substantially along the whole travel the cross-direction orientation device 17, in which case the film is not subjected to varying pressure stress or tensile strain, and thus the plastic film stretches sideways without tearing. In Figure 1 the plastic film 5, orientation wheel 18 and orientation band 19 are illustrated at a distance from one another for the sake of clarity, but in reality these parts are pressed firmly against one another. The orientation wheels 18 and the orientation bands 19 are arranged so that in the direction of the plastic film they are further away from one another at the end than at the beginning, as is illustrated in Figure 2, and thus the cross-direction orientation device 17 stretches and simultaneously orientates the plastic film 5 in the cross-direction. The deviation of the angle between the orientation wheels 18 and the orientation bands 19 from the machine direction can be adjusted according to the desired degree of cross-direction stretching. One or more band guide rolls 20 can be arranged to be rotated by the rotating means. Since the bands 19 are firmly pressed against the orientation wheels 18, the orientation wheels 18 do not necessarily need rotating means but may rotate freely. For the sake of clarity the enclosed figures do not illustrate rotating means or other actuators of the apparatus. A curved support plate 21, which has substantially the same shape as the circumference of the orientation wheels 18, is arranged between the orientation wheels 18 to support the plastic film 5.

The cross-direction orientation device 17 can be placed in a casing 26 of its own. If desired, the casing 26 can be provided with heaters known per se, such as radiation heaters, to heat the plastic film 5.

After the cross-direction orientation device 17 the plastic film 5 is led to a relaxation unit 22. In the relaxation unit 22 the plastic film 5 is relaxed, and thus the plastic film shrinks a bit in a manner known per se. Finally, the plastic film 5 is wound on a reel 23.

Figure 2 is a cross-sectional top view of the apparatus of the invention at the extruder 1. For the sake of clarity Figure 2 does not illustrate

the plastic film 5 or the support structures of the apparatus onto which the rolls, reels and plates of the apparatus are attached, for instance.

Figure 3 is a cross-sectional view of a detail of the extruder 1 along line A-A of Figure 1. Here both the outer stator and the inner stator 4 are round in cross-section. Thus the plastic material 5a is also in an annular feeding channel.

Figure 4 is a cross-sectional view of a detail of the extruder 1 along line B-B of Figure 1. Here we see the wide tip of the inner stator 4 and the shape of the nozzle 6 which extrude the plastic 5a into the wide and flat gap, and thus a flat plastic film 5 is formed from the plastic 5a.

Figure 5 is a cross-sectional view of a detail of the cross-direction orientation device 17 along line C-C of Figure 1. It is seen in Figure 5 how the orientation wheel and the orientation band are pushed against each other and press the plastic film 5 between each other. The surface of the support plate 21 against the plastic film 5 may be heated e.g. by providing it with heating resistors, and thus the plastic film 5 slides along the sliding surface in question very easily. Furthermore, propellant, such as air, can be blown from the support plate 21 through the gaps 21a, in which case the propellant flowing through the gaps 21a provides a sliding bearing between the support plate 21 and the plastic film 5. The gas in question may be heated, if desired, and thus the sliding surface of the support plate 21 and the plastic film 5 are heated with the propellant flowing through the gaps 21a.

Figure 6 illustrates an extruder 1 used in the apparatus according to the invention. The nozzle 6 of the extruder 1 widens up to the end portion of the extruder, i.e. up to the point where the plastic film 5 exits from the extruder 1. In the nozzle 6 of the extruder 1 the plastic 5a is thus all the time subjected to cross-direction orientation in addition to longitudinal orientation, which makes it considerably easier to orientate the plastic film in the cross-direction at a later processing stage.

Figure 7a is a side view of the plastic film 5. Before extrusion calcium carbonate particles 24 have been mixed into the plastic 5a. Instead of calcium carbonate particles 24 some other material may also be mixed into the plastic 5a. The material should be such that it causes the joint surface of the plastic molecules and the material mixed into the plastic 5a to tear when the plastic film 5 is stretched so that cavitation bubbles are formed where the joint surfaces are torn. Thus some oily substance, such as silicone oil or paraffin oil,

can be mixed into the plastic 5a. The particles mixed into the plastic 5a may cause spot-like asymmetry e.g. in the electric field in the plastic 5a, whereas the oily substance mixed into the plastic does not substantially worsen the electric properties of the plastic. It is also possible to mix a substance having a melting point lower than the orientation temperature of the plastic 5a, such as paraffin, into the plastic, in which case the substance melts when the plastic 5a is orientated. The plastic 5a may be made e.g. from polypropylene PP, polymethylpentene TPX or cyclic olefin copolymer COC. The heat resistance of polymethylpentene and cyclic olefin copolymer are better than that of polypropylene, for example. Electric charges also remain in polymethylpentene and cyclic olefin copolymer better than in polypropylene at high temperatures. Processing of polymethylpentene and cyclic olefin copolymer is very difficult but by the method and apparatus of the invention a very thin and foamed plastic film 5 can be made of them. In the situation illustrated in Figure 7a the plastic film 5 has not been stretched yet.

Figures 7b and 7c illustrate the plastic film 5 after it has been stretched in the machine direction orientation device 12, in which case the plastic film 5 has been simultaneously subjected to the pressure of the pressurized gas. In that case gas has diffused in the cavitation bubbles and caused overpressure in them, as a result of which bubbles 25 containing gas have formed. In the situation illustrated in Figures 7b and 7c the plastic film 5 has been subjected only to machine direction stretching, and consequently the bubbles 25 are long, flat and narrow.

Figure 7d illustrates a situation in which the plastic film 5 has also been stretched in the cross-direction by means of the cross-direction orientation device 17. The gas that was overpressurized in the bubbles 25 in the situation illustrated in Figures 7b and 7c has released in the lateral direction in the cross-direction orientation device 17. Thus the bubbles 25 are now also wide. In addition, the bubbles 25 are flat, i.e. they are plate-shaped or disk-like. The bubbles 25 are relatively small, their diameter is at most about 100 micrometers and their height is typically less than one micrometer, at most about 10 micrometers. However, the method and apparatus provide very thin plastic films 5. The thickness of the plastic films 5 may be only 10 micrometers.

The plastic film 5 can be used for several purposes in a manner known per se. At least one surface of the plastic film 5 can be provided with an

electrically conductive coating, for instance, in which case the solution can be used e.g. as a microphone or loudspeaker in several acoustic applications, including sound attenuation. The plastic film 5 may also be permanently electrically charged.

- 5 The drawings and the related description are only intended to illustrate the inventive concept. The details of the invention may vary within the scope of the claims. Thus the orientation directions of the plastic film 5 and the order of orientations in different directions may vary. According to the invention, the simplest way to make a plastic film is to orientate the plastic film
- 10 in the machine direction first and thereafter in the direction transverse to the machine direction.

CLAIMS

1. A method for producing a plastic film, the method comprising extruding a plastic film (5) and orientating it, **characterized** in that before extrusion material is mixed into the plastic (5a) of the plastic film (5),
5 cavitation bubbles are formed in the plastic (5) film to be stretched due to the influence of the material, after extrusion the plastic film (5) is orientated by stretching, and simultaneously with orientation pressurized gas is arranged to act on the plastic film (5) so that the gas diffuses in the cavitation bubbles, and thus bubbles (25) containing gas are formed in the plastic film (5).

10 2. A method according to claim 1, **characterized** in that gas is arranged to act on the plastic film (5) at the first orientation stage and thereafter the plastic film (5) is subjected to a second orientation which is substantially perpendicular to the first orientation so that the bubbles (25) containing gas expand due to the influence of the second orientation and the
15 gas.

3. A method according to claim 2, **characterized** in that at the first orientation stage the plastic film (5) is orientated in the machine direction and at the second orientation stage the plastic film (5) is orientated in the direction substantially transverse to the machine direction.

20 4. A method according to any one of the preceding claims, **characterized** in that the pressure of the gas acting on the plastic film (5) is over 3 bars.

5. A method according to any one of the preceding claims, **characterized** in that before extrusion an oily substance or a
25 substance having a melting point lower than the orientation temperature of the plastic (5a) is mixed into the plastic (5a).

6. An apparatus for making a plastic film, the apparatus comprising an extruder (1) and at least one orientation device (12, 17) for orientating the extruded film (5), **characterized** in that the apparatus comprises gas
30 supply means (15, 16) arranged in at least one orientation device (12, 17) for feeding pressurized gas into the plastic film (5) simultaneously with orientation by stretching so that the fed gas diffuses in the cavitation bubbles that are formed in the plastic film (5) during stretching, and thus bubbles (25) containing gas are formed in the plastic film.

7. An apparatus according to claim 6, **characterized** in that the gas supply means (15, 16) are arranged in the first orientation device (12) and that the apparatus comprises a second orientation device (17) after the first orientation device (12) in the direction of the plastic film (5), the second
5 orientation device (17) being arranged to orientate the plastic film (5) in the direction substantially transverse to the orientation direction of the first orientation device (12) so that the bubbles (25) containing gas expand due to the influence of the second orientation device (17) and the gas.

8. An apparatus according to claim 7, **characterized** in that
10 the first orientation device (12) is arranged to orientate the plastic film (5) in the machine direction and the second orientation device (17) is arranged to orientate the plastic film (5) in the direction substantially transverse to the machine direction.

9. An apparatus according to any one of claims 6 to 8,
15 **characterized** in that the gas supply means (15, 16) comprise a discharge chamber (15), in which case at least one orientation device (12, 17) is arranged inside the discharge chamber (15) so that the pressure of the gas in the discharge chamber (15) acts on both sides of the plastic film (5) simultaneously with the orientation effect of the orientation device (12, 17).

20 10. An apparatus according to any one of claims 6 to 9, **characterized** in that the extruder (1) comprises a nozzle (6) which is arranged to widen up to the end portion of the extruder (1).

11. An apparatus according to any one of claims 6 to 9, **characterized** in that the apparatus comprises a cross-direction
25 orientation device (17), which comprises two orientation wheels (18) and endless orientation bands (19) which are arranged against the wheels and move around band guide rolls (20), both edges of the plastic film (5) to be orientated being arranged between the orientation wheel (18) and the orientation band (19) and the orientation wheels (18) and the orientation bands
30 (19) being arranged so that in the direction of the plastic film (5) they are further away from one another at the end than at the beginning, in which case the cross-direction orientation device (17) stretches the plastic film (5) in the cross-direction.

12. An apparatus according to claim 11, **characterized** in
35 that the apparatus comprises a curved support plate (21), which is arranged between the orientation wheels (18) to support the plastic film (5).

13. An apparatus according to claim 12, **characterized** in that the support plate (21) is provided with gaps (21a) and heated gas is arranged to flow through the gaps to heat the sliding surface of the support plate (21) and plastic film (5).

5 14. A plastic film, which comprises bubbles (25) with the maximum diameter of about 100 micrometers and the maximum height of about 10 micrometers, **characterized** in that material is mixed into the plastic (5a) of the plastic film (5), cavitation bubbles are formed in the stretched plastic film due to the influence of the material and the plastic film is subjected
10 to stretching and to pressure of pressurized gas simultaneously with stretching so that the bubbles (25) contain said gas, the foaming degree of the plastic film (5) being over 70%.

15 15. A plastic film according to claim 14, **characterized** in that an oily substance or a substance having a melting point lower than the orientation temperature of the plastic (5a) is mixed into the plastic (5a) to provide the cavitation bubbles that are formed during stretching.

16. A plastic film according to claim 14 or 15, **characterized** in that the plastic film is made of polymethylpentene (TPX).

20 17. A plastic film according to claim 14 or 15, **characterized** in that the plastic film (5) is made of cyclic olefin copolymer (COC).

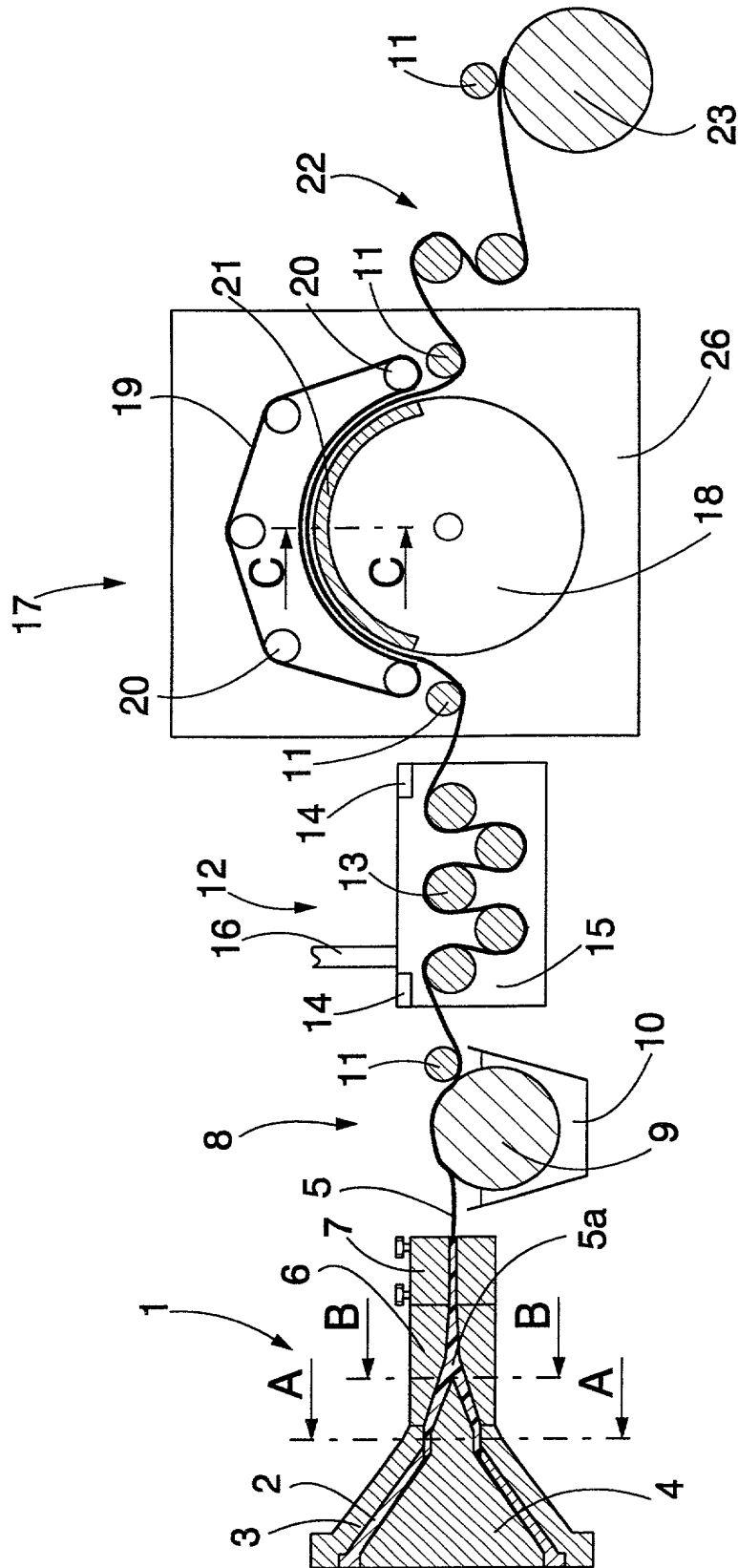


FIG. 1

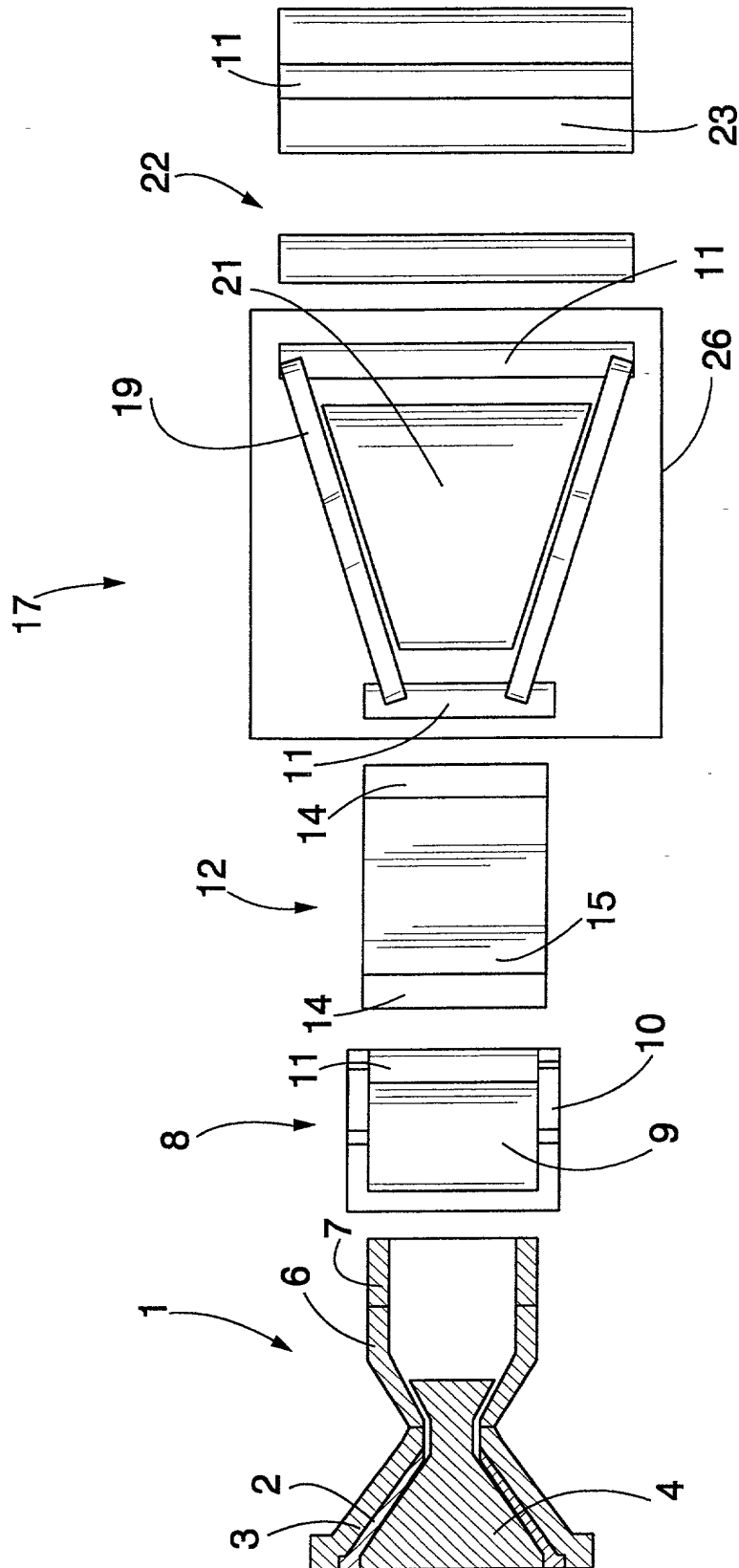


FIG. 2

3/4

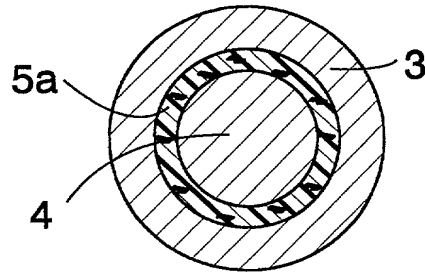


FIG. 3

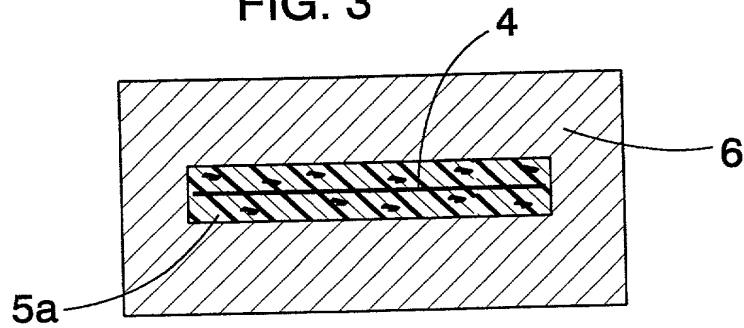


FIG. 4

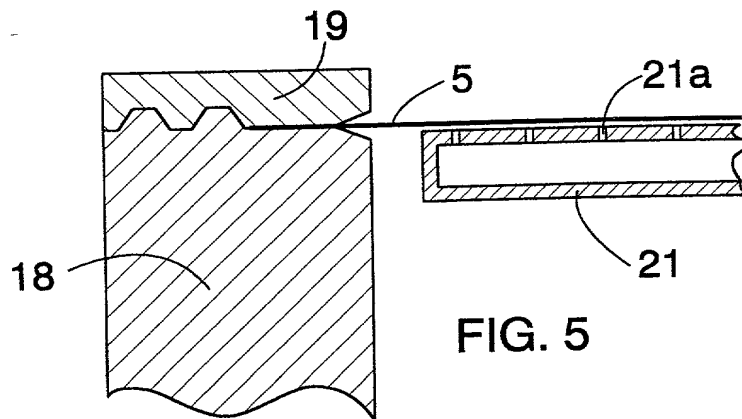


FIG. 5

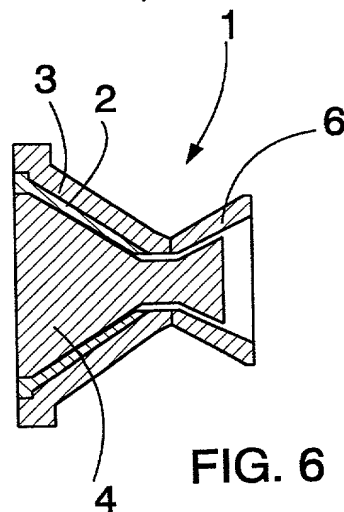
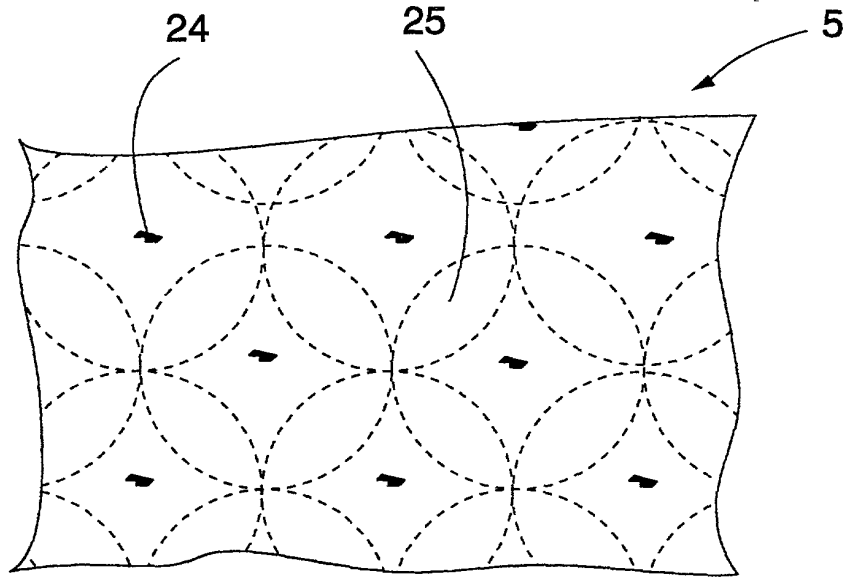
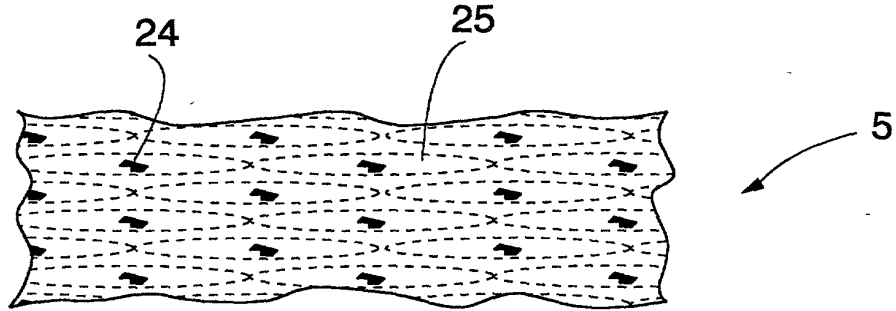
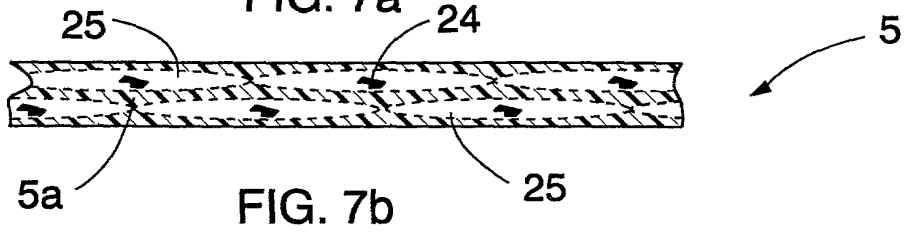
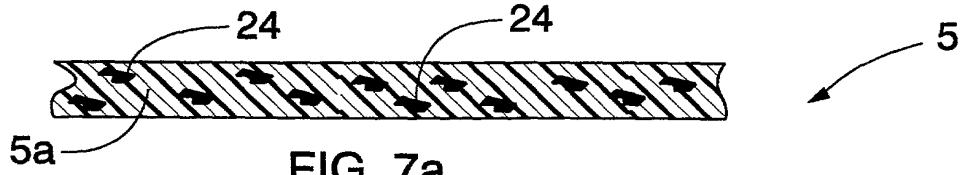


FIG. 6

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COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Method and apparatus for making plastic film, and plastic film

the specification of which: *(check one)*

REGULAR OR DESIGN APPLICATION

- ☐ is attached hereto.
- ☐ was filed on _____ as application Serial No. _____ and was amended on _____ (if applicable).

PCT FILED APPLICATION ENTERING NATIONAL STAGE

- ☒ was described and claimed in International application No. PCT/FI99/00277 filed on 1 April 1999 and as amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

PRIORITY CLAIM

I hereby claim foreign priority benefits under 35 USC 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)

Country	Application Number	Date of Filing (day, month, year)	Priority Claimed
Finland	980800	7 April 1998	Yes

(Complete this part only if this is a continuing application.)

I hereby claim the benefit under 35 USC 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status--patented, pending, abandoned)

POWER OF ATTORNEY

The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from _____ as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

As a named inventor, I hereby appoint the following attorney(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: **Robert J. PATCH, Reg. No. 17,355, Andrew J. PATCH, Reg. No. 32,925, Robert F. HARGEST, Reg. No. 25,590, Benoît CASTEL, Reg. No. 35,041, Eric JENSEN, Reg. No. 37,855, and Thomas W. PERKINS, Reg. No. 33,027, c/o YOUNG & THOMPSON, Second Floor, 745 South 23rd Street, Arlington, Virginia 22202.**

Address all telephone calls to Young & Thompson at 703/521-2297.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: ^{FD} Kari KIRJAVAINEN
(given name, family name)

Inventor's signature  Date 27.7.2000

Residence: Tampere, Finland ^{Fix} Citizenship: Finnish

Post Office Address: Palomäentie 14 B 13, FIN-33230 Tampere, Finland

Full name of second joint inventor, if any:
(given name, family name)

Inventor's signature _____ Date _____

Residence: _____ Citizenship: _____

Post Office Address: _____

Full name of third joint inventor, if any:
(given name, family name)

Inventor's signature _____ Date _____

Residence: _____ Citizenship: _____

Post Office Address: _____